AN OUTBREAK OF TONSILITIS OR SEPTIC SORE THROAT IN EASTERN MASSACHUSETTS AND ITS RELATION TO AN INFECTED MILK SUPPLY.*†

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INTRODUCTION.

A sudden increase in cases of acute tonsilitis in certain parts of the city of Boston and its suburbs was talked of at a medical meeting in Boston on the evening of Thursday, May 11, 1911. By Sunday, May 14, the laboratories of the health departments were on the *qui vive*, for in many cases the disease simulated diphtheria, and in Boston, for example, there was an increase of 100 per cent in the cultures examined on May 14 as compared with the previous Sunday. In the Back Bay district of Boston, in Brookline and Cambridge, where the disease was most prevalent, individual physicians had from 20 or 30 to 60 or 70 cases of tonsilitis of a peculiar and characteristic type within a period of a week.

Certain physicians who were dealing immediately with the disease were quickly impressed with the fact that most of the families affected used a single milk supply, that from the Deerfoot Farms. The matter was brought to the attention of the officers and experts of the dairy company on May 13 and 14, and experts of the company as well as the inspectors of the Boston Health Department at once investigated conditions at the dairy and on the farms but without finding any evidence of a cause for the disease. Since the Deerfoot Farms Company had supplied milk in Boston for 28 years and in that time had been universally regarded as a pioneer in the work of dairy inspection and in the marketing of clean milk, many were loath to believe that it could possibly be involved. Physicians in other regions, and certain of the sanitary officials concerned, held that the Boston-Brookline-Cambridge outbreak was only part of a general excess of throat disease due to dust and extreme dry weather, and

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that the coincidence with a particular milk supply in the district affected was merely a local and accidental one. It was known that tonsilitis was prevalent in Hudson, where no Deerfoot milk is delivered, and also in Marlboro, where studies by Dr. W. W. Walcott of the State Department of Health showed no special incidence of disease among Deerfoot milk users. The uncertainty was so great that the local health departments concerned hesitated to take any definite position, in spite of the urgent requests of the company for advice and its willingness to take any steps that might be suggested.

About the middle of June, I was called in by Mr. Robert M. Burnett of the Deerfoot Company and asked to make a thorough study of the entire situation, and to make my findings public in such manner as I should see fit.

Tonsilitis is not a reportable disease and my records were obtained by conference with individual physicians, over 80 of whom were personally interviewed. Beginning my work so long after the event, there remain many lacunae which it has been impossible to fill. Nevertheless, I have been able, through the courtesy of these physicians, to obtain fairly complete records of 1,400 cases of the disease; and from a study of these records, in conjunction with other facts, it has been possible to reach a reasonably clear conclusion as to the general course and causation of the outbreak.

THE DISEASE.

A word should first be said about the disease itself. It was commonly called tonsilitis, but differed from ordinary tonsilitis in some respects, and was held by many physicians to be a new and peculiar pathological condition. The following picture is made up from conversation with a large number of the physicians who had treated it; and no one who has talked with many such can doubt that they have been dealing with a definite and specific entity. The disease is a variable one, and single cases may present hardly a feature in common with each other, but any series of 20 cases shows at once its characteristic features.

The onset of the attack was rapid and often accompanied by severe headache and acute grippy pains. The temperature was

high, often 103°–105°. The throat was somewhat variable in appearance. At first there was a general diffuse redness extending over the tonsils and pharynx and adjacent regions, much like a scarlet fever throat. Later small isolated patches of white usually appeared, resembling the plugs of ordinary follicular tonsilitis. Still later in many cases there was an extensive membrane-like exudate simulating diphtheria. Frequently one tonsil was swollen first, followed by the other, and there was almost always more or less invasion of the cervical lymph nodes.

This first stage of the disease lasted for three to five days and was followed by recovery or by secondary complications. In either case the patient usually experienced great prostration. The commonest complications were abscesses in the peritonsillar region and in the cervical glands. The infecting organism, whatever it was, did not stay long in the throat, and affections of the nose and ear were relatively rare. It was the deeper tissues that were affected and abscesses produced were exceedingly painful and difficult to handle. Operations often failed to locate any pus, and after a time the abscesses discharged themselves, but the neck remained in a painful condition for a long period afterward.

In still more serious cases complications followed, of a more general septic nature. The occurrence of these acute complications was closely dependent upon the general condition of the patient. With children and young people the whole course of the disease was light; but with the old or those of low resistance, almost any weak organ might be attacked. Rheumatism was perhaps the commonest complication. Erysipelas was another. Nephritis occurred in a number of instances. Pleurisy and pneumonia in many cases followed the initial attack. The heart was frequently affected. One patient, Mrs. L., had, in succession, following her sore throat, erysipelas, pneumonia, and pericarditis. In the most dangerous cases of all, including many of the fatalities, there was a general systemic infection, leading to septicemia or peritonitis.

All these symptoms point to a streptococcus as the probable cause of infection, but there is as yet no definite information in regard to the bacteriology of the outbreak. Throat cultures examined at the Boston Board of Health Laboratory and elsewhere

showed no constant organism but Professor Theobald Smith, of the Harvard Medical School, has four cultures isolated from internal organs in the more severe cases, all of which are streptococci of apparently the same type. It is hoped that these may prove significant. I have no first-hand information on this point myself, as it was too late to do any bacteriological work when I was called into the case.

The disease described above is evidently something different from ordinary follicular tonsilitis, according to the opinion of all the physicians who have had most experience with it. So far as I am aware it has not before been noted in this country. Precisely similar outbreaks have occurred several times, however, in Great Britain, and in each case they have been traced to milk. The English have called such outbreaks "septic sore throat" and I have ventured to suggest this title as an alternative to the term tonsilitis which has been popularly applied to the present outbreak.

GEOGRAPHICAL DISTRIBUTION OF THE DISEASE.

Systematic inquiry soon made it clear that the distribution of the disease, as far as any abnormal excess was concerned, was far more restricted than rumor had suggested. Of course there is always some tonsilitis everywhere; and at any time certain localities may be expected to show more cases than normal, and many cities had a good deal of tonsilitis in the winter and spring of 1911. Such a condition as that which existed in Boston during the early part of May is, however, quite a different matter. When individual physicians have 50 cases within a week, and of a peculiarly severe type, and when the routine laboratory cultures of a large city show a sudden increase of 100 per cent, the condition is obvious to everyone and may properly be called epidemic.

Outside of Massachusetts I have been unable to find any abnormal epidemic prevalence of tonsilitis or any occurrence of peculiar septic throat disease during the winter and spring of 1911, with a single exception. There was a rumor that the disease had prevailed extensively in Washington and New York and was brought first to Massachusetts by a party of school teachers from Marlboro and Southboro who had been on an excursion to the former city. It

transpired, however, that this excursion was made long after the disease had broken out in the home towns of the excursionists and they presumably had carried the infection with them. Inquiries kindly made for me in Washington by Dr. W. F. Cuthbert among physicians of his acquaintance failed to show any excess of tonsilitis, and the local health department had no knowledge of any outbreak. Dr. R. W. Baker writes, "My recollection is that we had a large number of cases of tonsilitis in Washington last year—but we always have that." Dr. J. H. Bryan writes, "We had no epidemic of tonsilitis here, and there was nothing peculiar in the cases I saw from the usual form of this trouble that so frequently prevails in spring." Dr. A. B. Bennett reports no unusual prevalence of the disease. In New York again the local health department was not aware that anything unusual had occurred and certainly no tonsilitis epidemic was generally recognized among the physicians there.

Just outside New York City, however, in the town of Rye and adjacent parts of Westchester County, there appears to have been an outbreak of a peculiar type during the months of February and March. It prevailed for the most part among children, and there were no very severe complications, but Dr. Arthur S. Corwin, of Rye, who had 50 cases in his own practice, described to me the diffusely reddened throats, the diphtheria-like membranes, and the enlarged cervical glands which were so characteristic of the Massachusetts epidemic. I have no hint, however, of any connection between the two outbreaks.

As to the distribution of the disease within the state of Massachusetts, valuable information was courteously furnished to me by Dr. H. P. Walcott, chairman, and the other officials of the state board of health. As soon as the outbreak in Boston and Cambridge attracted attention the district medical inspectors were ordered to investigate the prevalence of the disease within their districts, and with the exception of two definite foci of infection, their reports were uniformly negative. The disease prevailed in epidemic form in Boston, Brookline, and Cambridge on the one hand, and in Hudson, Marlboro, and Southboro on the other; the rest of the state showed no abnormal conditions. In Worcester, where the newspapers reported 2,000 cases, a careful canvass of the physicians

showed nothing unusual, and Dr. J. C. Coffey, the health officer of the city, stated that the laboratory cultures showed no increase and that no outbreak came to his attention.

In view of the statements repeatedly made that there was much tonsilitis in the cities and towns of Framingham, Wellesley, Natick, and Newton, which lie along the Boston and Albany Railroad and connect the two principal centers of infection to which reference has been made, I made a special study of conditions in those communities. The western part of the town of Framingham shared in the epidemic of the adjoining districts of Southboro, and one physician, a member of the local health board, reports "quite a few cases." On the other hand, two other doctors, one of them the school physician, had noted no excess. In the adjoining town of Natick, to the east, five physicians were interviewed, including the school physician. All were agreed that there had been nothing abnormal here. In the Nathan Rice School there was a small outbreak of 10 or 12 cases about May 15; but they were light cases, of the ordinary follicular type. In the town of Wellesley the health officer, Mr. C. K. Blanchard, on hearing of the Boston outbreak, telephoned (May 26) to six physicians of the town, and found that there had been a slight excess of tonsilitis over the normal but nothing marked. There did occur, in the town of Wellesley, an interesting community outbreak which was simultaneous with the Boston epidemic but apparently in no way connected with it. In a Roman Catholic academy with about 125 children, 30 of the children and several teachers came down on May 8 all at once with a rather mild tonsilitis. The academy has its own milk supply, and for the most part its own food supplies, and so far as could be learned nothing had been brought in that could convey infection. Two of the sisters had quinsy sore throats in March and indications point to a local infection of some food supply within the institution, perhaps by an unrecognized carrier case.

In the city of Newton again there was no general excess of tonsilitis, except in the eastern part where it adjoins Watertown and Brookline and Brighton. Dr. F. G. Curtis, chairman of the board of health, and representative physicians in West Newton and Newtonville all testified to the absence of any general epidemic.

There was thus no connection between the two isolated foci centering at Boston and at Marlboro respectively. Inquiry into cases said to have occurred in other scattered localities, as at Scituate and Lowell, either gave no results or revealed a direct connection with the Boston outbreak.

The geographical distribution of the disease within the affected towns is also definite and worthy of notice. In Brookline the cases were confined chiefly to the Longwood district and to the region in the vicinity of Village Square. There was little or no disease beyond Harvard Street in the Chestnut Hill region. In Cambridge sickness was closely localized in North Cambridge and Old Cambridge, with little or none in the southeastern part of the city. In Boston the disease prevailed most extensively in the Back Bay and Allston, although cases occurred in South Boston, Dorchester, and Roxbury, with a few in East Boston. Charlestown and the North End with the adjoining cities of Chelsea, Revere, and Winthrop showed no excess.

It may be noted that all the districts specially affected were residential districts of a high class. The poorer portions of the city showed only a very slight response, such as might be expected on account of occasional contact through servants and in other obscure ways. Thus at the out-patient department of the Massachusetts General Hospital there were four new cases of acute tonsilitis treated during the first week of May, seven during the second week, 10 during the third, and three during the fourth. At the Boston Dispensary the corresponding figures were 3, 7, 10, and 4. In each case the outbreak in the second and third weeks was registered by a very slight increase.

EXTENT OF THE BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

With a non-reportable disease like tonsilitis it is of course impossible to gain an exact idea of the extent of an epidemic like that under consideration. In Brookline the local health department sent out two circulars to physicians, one on May 15 asking for a report of cases of tonsilitis since April 24, and another on May 25 asking for subsequent cases. These records were very courteously placed at my disposal, and from them and from interviews with a

few of the physicians I have compiled records of a total of 304 cases. This probably gives a fairly complete record of the outbreak, and not only so but it must include many cases of ordinary tonsilitis which would have arisen in the ordinary course of affairs in a community of 28,000 persons.

In Boston and Cambridge no official canvass was made, except that in Boston telephonic reports were obtained from physicians who sent in cultures for diagnosis. These were kindly placed at my disposal, but most of my cases were obtained by direct conference with the physicians themselves. In selecting physicians I naturally sought those who were reported to have had many cases and in this way I obtained mainly a record of the sharp outbreak, and not of the ordinary run of tonsilitis cases, of which the practitioners in other districts would normally have half a dozen during a month. Thus my Boston and Cambridge records represent the special outbreak, while the Brookline data include all tonsilitis of any type whatever.

In Cambridge the disease was sharply localized and was concentrated in the practice of a comparatively small number of physicians. I found 399 cases, but my canvass even here was very incomplete for Dr. E. A. Darling,[1] in a special study of the Cambridge outbreak, received from 35 physicians reports of 730 cases. In Boston the disease was scattered among a much larger number of physicians and my records represent a still smaller proportion of the total. In the Back Bay district I found 294 cases and in Allston 46 cases, but I made no canvass at all of South Boston, Roxbury, and Dorchester, where some cases occurred. The Boston Board of Health estimates 800 cases for the whole city and the figure is certainly a conservative one.

The total number of cases collected by me and used in my studies was therefore as follows: Boston (Back Bay), 294; Boston (Allston), 46; Brookline, 304; Cambridge, 399; total, 1,043.

EPIDEMIOLOGICAL CHARACTERS OF THE BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

Dates.—The distribution of the disease in time is indicated in Table 1 and in Fig. I. The dates given are, as usual in such

[1] *Boston Med. and Surg. Jour.*, 1911, 165, p. 904.

cases, those of the first visit of the physician, except in the case of a specialist called in for secondary complications, when the actual date of onset was estimated. In the late cases there had usually been a considerable period of sickness before the doctor was called in. In Brookline definite dates are lacking for many of those cases derived from the Health Department reports.

TABLE 1.

DATES OF ONSET, BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

DATE	DISTRICTS				
	Boston (Back Bay)	Boston (Allston)	Brookline	Cambridge	Total
April 22	1	..	..	..	1
24	3	..	2	..	5
May 3	..	..	1	1	2
4	9	..	1	4	14
5	1	..	..	1	2
6	3	..	..	1	4
7	1	..	1	1	3
8	3	..	3	6	12
9	17	1	9	6	33
10	15	..	12	19	46
11	18	11	12	33	74
12	48	8	19	64	139
13	52	..	29	52	133
14	61	6	19	72	158
15	27	3	27	46	103
16	12	2	10	23	47
17	6	7	2	16	31
18	1	3	..	15	19
19	2	..	2	13	17
20	1	1	1	4	7
21	1	..	1	4	6
22	..	..	2	4	6
23	..	..	1	1	2
24	..	..	2	..	2
25	..	..	..	1	1
26	..	..	1	..	1
27	..	..	3	..	3
28	1	1	..	..	2
30	2	..	..	..	2
June 2	1	..	..	..	1
5	1	..	1	..	2
6	..	..	1	..	1
Unknown	7	3	142	12	164

It is clear that we are dealing not with a diffuse prevalence of the disease but with a single (or perhaps double) sharply marked epidemic, culminating on the 12th, 13th, and 14th of May. The six April cases were most probably ordinary tonsilitis not connected with the main outbreak. I am inclined to believe, however, that the 14 cases on May 4 are significant, and indicate a very slight infection of the same general nature as that which caused the major outbreak. If so, it is an interesting illustration of a slight outbreak such as would never have been detected if the main epidemic had

not followed it, and such as probably does occur quite frequently without detection.

The major outbreak began on May 8 or May 9, quickly rose to a maximum, and again fell off, new cases having practically ceased by May 23. The curve points clearly to a single source of infection (except for the small outbreak of May 4) but perhaps to an infection extending over a period of several days. The evidence in half a

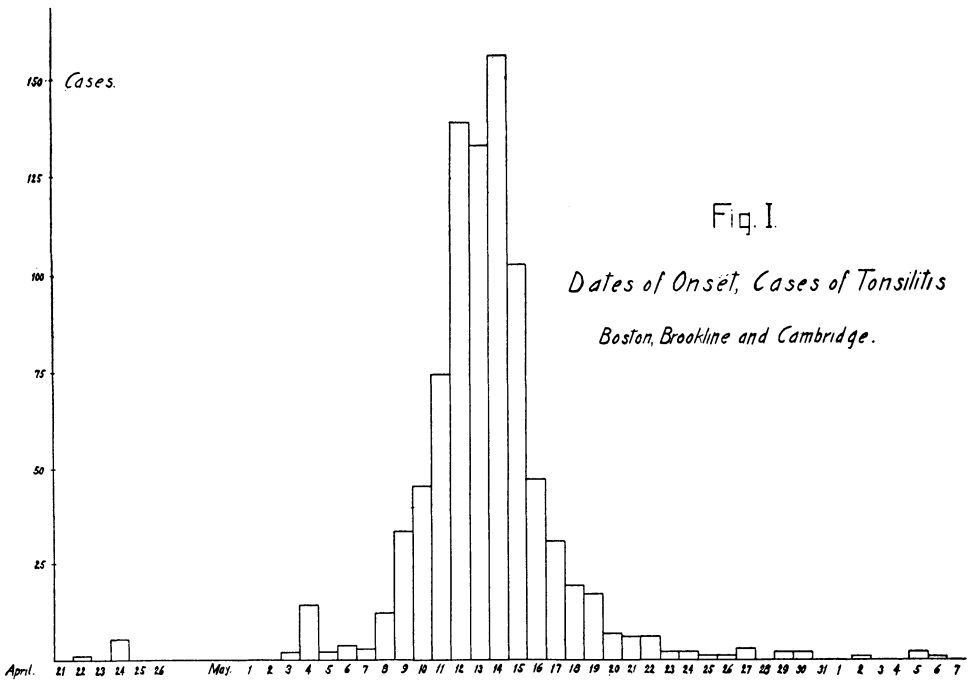

Fig. I.

Dates of Onset, Cases of Tonsilitis

Boston, Brookline and Cambridge.

dozen cases where the time of infection can be fixed points to an incubation period of from two to three days, and the dates of the infection would on this hypothesis have been between the eighth and 11th of May.

The curve is so compact as almost to preclude the occurrence of any large number of secondary cases derived by contact from the primary outbreaks. Physicians were unanimous in holding that very few such secondary cases occurred. It may be concluded, therefore, that the disease was almost non-contagious in the form

and under the conditions in which it occurred in the neighborhood of Boston.

Family incidence.—The number of cases occurring in a household is shown in Table 2.

TABLE 2.

FAMILY INCIDENCE, BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

NUMBER OF HOUSEHOLDS IN EACH CLASS.

Locality	Number of Cases in a Household						
	1	2	3	4	5	6	7
Boston (Back Bay)*	89	29	16	6	4	5	..
Boston (Allston)	7	8	4	..	1	1	..
Brookline	101	31	17	9	2	5	2
Cambridge	107	53	20	12	8	4	2
Total	304	121	57	27	15	15	4

* 25 cases at an Art Students' Club.

The table indicates a heavy incidence upon the affected households. Of the families in which cases occurred 56 per cent had one case, 22 per cent two cases, 11 per cent three cases, and 11 per cent four cases or more. In view of the lack of evidence of secondary contact, these figures indicate that the common carrier of infection must have been a somewhat virulent one.

Sex incidence.—Data in regard to the sex of patients are given below in Table 3. They are somewhat incomplete, as certain physicians reported simply "cases" except for the name identifying

TABLE 3.

SEX INCIDENCE, BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

	Male	Female	Unknown
Boston (Back Bay)	42	157	95
Boston (Allston)	13	25	8
Brookline	66	99	139
Cambridge	94	241	64
Total	215	522	306

the household, and in the first part of the investigation no special effort was made to obtain fuller data. The records tabulated are sufficient, however, to bring out one striking fact—the very heavy incidence of the disease upon women. Twenty-nine per cent of my cases were males and 71 per cent females. It was thought at

first that this might be accounted for by the large number of cases among domestic servants, but an examination of the cards showed only 65 servants among the Cambridge and 62 among the Boston cases, not enough nearly to account for the discrepancy. It appears that there was some definite reason why females should be sufferers and reasons will later be brought forward for believing this to be less on account of greater susceptibility than on account of a greater exposure to infection.

Age incidence.—Data in regard to age distribution were not generally obtained but a special effort was made to collect them in the Cambridge canvass, as it was thought this city might serve as a type of the rest. The results are grouped by age periods in Table 4. For convenience the Cambridge deaths are grouped together with the cases, although the general subject of fatalities must receive special consideration by itself.

TABLE 4.

AGE INCIDENCE, CAMBRIDGE EPIDEMIC.

	Age Periods										
	0–5	6–15	16–25	26–35	36–45	46–55	56–65	66–75	76–85	86–95	Unknown
Cases	19	39	77	90	53	35	35	18	11	1	21
Deaths	1	0	2	0	1	4	4	5	5	1	0

The most significant thing about this table is the small proportion of children affected. Infants were almost free from the disease and even children of school age showed a comparatively small number of cases. Young adults between 16 and 45 included more than half the total. The gravity of the disease increased markedly with advancing years. Ninety cases between the ages of 26 and 35 did not include a single death, while after the age of 65 there were 37 per cent of fatalities and after the age of 75, 50 per cent.

Fatalities.—I have obtained, altogether, records of 48 fatal cases attributed to the Boston-Brookline-Cambridge outbreak of tonsilitis. There are considerable elements of uncertainty in the establishment of the relation between the original disease and its final sequel, because death often occurred from a complication of a somewhat remote kind. In some instances there was a rapid

septic invasion with no other symptoms. In most instances, however, the original throat attack was followed by pneumonia or by a heart attack or by some other affection, due partly to the weakening effect of the tonsilitis germ and partly to an original constitutional disability. Most of the deaths were among the old and weak, and the tonsilitis by itself would perhaps not have proved serious without these contributory causes.

The 48 deaths considered were distributed by places as follows: Boston (Back Bay), 18; Boston (Allston), 1; Brookline, 6; Cambridge, 23.[1] Seventeen were males and 31 females. The age distribution is indicated in Table 5.

TABLE 5.

AGE INCIDENCE, FATAL CASES, BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

	Age Period									
	0–5	6–15	16–25	26–35	36–45	46–55	56–65	66–75	76–85	86–95
Deaths.....	5	1	0	4	2	4	8	9	12	3

The table shows that with the exception of five deaths among infants and five among young adults fatalities were for the most part confined to ages above 45. Two-thirds of the deaths occurred at ages above 55, nearly half at ages above 65, and about one-third at ages above 75.

THE CAUSATIVE AGENT IN THE BOSTON-BROOKLINE-CAMBRIDGE EPIDEMIC.

There are three distinct possibilities to be considered in examining an outbreak of disease. The cause may lie, not in the spread of an infectious element, but in climatic or other general environmental conditions which in some way affect the human mechanism so as to favor the development of disease. Or an infection may spread from person to person by various irregular paths—by contact, by various foods, or perhaps by dust or the like, the path of infection being different in almost every case. This is known as prosodemic infection. Or, finally, the disease may occur in epidemic form, being spread at once to a large number of persons by a common source

[1] Dr. Darling in his investigation found 27 deaths in Cambridge.

of infection. All these three theories have had their adherents in connection with the outbreak under consideration.

The geographical distribution of the disease, in my judgment, negatives the first theory of general climatic influence. A dry spring, a large amount of dust, streets sprinkled with oil, and various other external physical conditions may or may not influence the spread of tonsilitis, but in any case there is no evidence that such conditions existed any more markedly in the affected districts than in others where there was no excess of tonsilitis. It was no drier and no more dusty in Cambridge than in Waltham, in Brookline than in Newton, in Boston than in Everett or Malden or Hyde Park. Clearly there was some definite source of infection in certain districts which was absent in others.

With regard to the view that tonsilitis was spread in prosodemic fashion, passing from person to person by diverse paths, the dates of the outbreak are practically conclusive. When disease spreads in this way, as tonsilitis and most minor nose and throat infections ordinarily spread, there is no special concentration in time. Cases straggle along for weeks and perhaps months. A sharp localization of a large number of cases, such as was so clearly manifest in the Boston-Brookline-Cambridge outbreak, points clearly to a single source of infection.

The simultaneous outbreak of epidemic tonsilitis on May 8 and the succeeding days in the town of Brookline and the cities of Boston and Cambridge, indicated graphically in Fig. II, must have been due to a common cause; and so far as I am aware, only two vehicles of infection—water and milk—have ever been found capable of producing such a phenomenon on so large a scale. It is quite inconceivable, even if dust ever spreads the germs of disease, that such a sudden and general infection should be due to this cause. Insects are not known to spread tonsilitis and are not prevalent in the vicinity of Boston in early May. Food supplies, like shell-fish, lettuce, and the like, are not distributed from any single common source to the large and widely separated districts under consideration. Probability pointed to one of the two more universal vehicles, water or milk, and since the water supplies of the three communities are distinct, more particularly to milk supply. A

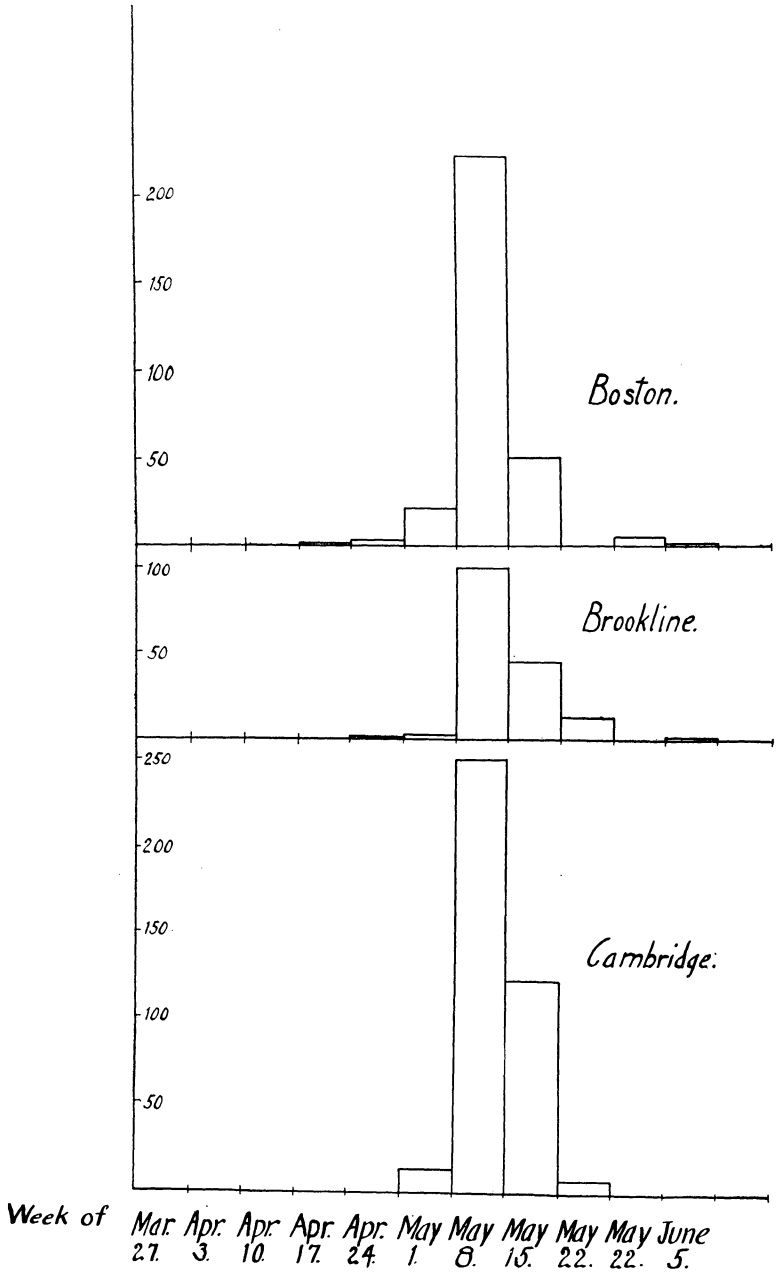

Fig. II.

Weekly Incidence of Tonsilitis Cases: Boston, Brookline, Cambridge.

study of the relation between milk and the disease quickly showed this suspicion to be justified.

In the first place, it appeared that the general geographical distribution of the disease coincided closely with a single supply of milk. The Deerfoot Farms have two main supplies, one from Southboro and one from Northboro, and a supply of cream which is common to the two. It was the Southboro supply of milk alone which corresponded with the spread of tonsilitis. Wherever the Northboro supply went, no trouble occurred, a fact which explains why customers in certain large areas suffered no infection. Besides the car sent to Boston, milk was delivered direct from the Southboro dairy in Southboro and Marlboro. In both these places, as will be noted later, there was an outbreak of tonsilitis simultaneous with that in the neighborhood of Boston. Of the Southboro milk sent to Boston in the early part of May over 2,000 quarts were delivered in the Back Bay region. Here I have records of about 300 cases of tonsilitis, but as stated, these records are very incomplete and must represent at least 600 actual cases. Cambridge received nearly 1,000 quarts of milk and there I found about 400 cases. Brookline received about 600 quarts and there the complete board of health returns (including ordinary tonsilitis as well as the special epidemic) show 300 cases. In Allston with over 100 quarts of milk I found 46 cases. About 250 quarts of milk apiece were delivered to Roxbury and Dorchester, and 150 to South Boston. In none of these places did I make any systematic canvass, but in all it was ascertained by the Boston Board of Health that the disease occurred, and this fact was confirmed by local physicians interviewed by me. Wherever the Southboro milk went there was an excess of tonsilitis in the second and third weeks of May. In no district near Boston where it did not go was there any such excess, with one possible exception. In East Boston, it was reported to me by one physician with a large practice that he had three to 10 office cases of tonsilitis a day during the period of the general epidemic. Other physicians did not remember any such experience and it was impossible to get records of the specific cases. Skim milk from the Southboro dairy is sold in East Boston, and it is possible that this may explain the apparent anomaly.

On the whole, the general correspondence between Southboro milk and tonsilitis appears too close to be accidental. Furthermore, the parallelism extended to districts within the towns, as well as to the towns themselves. The various sections of Boston have already been considered separately, but the same phenomenon was apparent in Brookline and Cambridge. In the former town, tonsilitis prevailed in the Longwood district and near the old village, in the latter it occurred in North Cambridge and near Harvard Square, just where the Southboro milk is distributed.

The real test, of course, is the coincidence between milk supply and disease in the individual household; and on this point full data have been collected. In the first place, the physicians who gave me the cases were asked for any notes they might have made in regard to milk supply, and in the second place the names and addresses of the cases were carefully compared with the May 1 delivery lists of the Southboro milk, furnished to me by the Deerfoot Company. By this means the cases have been divided into three classes; those which appear on the milk lists; those which are believed by the physicians to have used the milk but do not appear on the lists; and those which are not known to have used the milk at all.

TABLE 6.

RELATION BETWEEN SOUTHBORO MILK AND TONSILITIS IN BOSTON AND CAMBRIDGE.

LOCALITY	CASES ON SOUTHBORO LIST		CASES SAID TO HAVE USED SOUTHBORO MILK BUT NOT ON LIST		CASES NOT KNOWN TO HAVE USED SOUTHBORO MILK	
	Number	Percentage	Number	Percentage	Number	Percentage
Boston (Back Bay)	251	85	22	8	21	7
Boston (Allston).....	44	96	1	2	1	2
Cambridge.....	342	86	32	8	25	6

As far as Boston and Cambridge are concerned, over 85 per cent of the cases of tonsilitis appear on the Deerfoot Farm lists and 8 per cent more are believed by the physicians to have used the milk. In 11 out of the 32 cases in the doubtful class in Cambridge, the history of the use of milk at a friend's house or at work was quite definite and specific. It may be said that between 85 and 90 per cent of the cases of epidemic tonsilitis in Boston and Cambridge are

known to have used Southboro milk; and since this milk makes up less than 1 per cent of the total Boston supply and only a little over 2 per cent of the total of the Cambridge supply the evidence of a causative relation between the milk and the tonsilitis is irresistible.

TABLE 7.

RELATION BETWEEN SOUTHBORO MILK AND TONSILITIS IN BROOKLINE.

CASES ON SOUTHBORO LIST		CASES SAID TO HAVE USED SOUTHBORO MILK BUT NOT ON LIST		CASES NOT KNOWN TO HAVE USED SOUTHBORO MILK	
Number	Percentage	Number	Percentage	Number	Percentage
198	65	23	8	83	27

In Brookline, as indicated in Table 7, the results are somewhat different, because in Brookline the data include all cases of tonsilitis, and not merely the special epidemic. On such a basis as this it appears that something over 70 per cent of the cases were supplied with Deerfoot milk. A tabulation kindly furnished by the Brookline Board of Health, of cases in which the milk supply was definitely known, showed 214 cases among Deerfoot milk users and 56 distributed among 18 other dealers, the largest number on any one route being eight in one case and six in two others. The smaller percentage of Deerfoot cases in Brookline is precisely what should be expected, for the more ordinary disease is included, the less striking will be the relationship. In any large community there must always be a considerable amount of tonsilitis, irrespective of any special epidemic. This is shown in an even higher degree by the results of the house-to-house canvass carried out on May 26 under the direction of Dr. F. H. Osgood, veterinarian to the Brookline Board of Health. In this canvass all cases of sore throat were included, and 162 out of 474 houses supplied with Deerfoot milk were affected, against 161 houses out of 2,865 supplied from other sources. Thus about 50 per cent of all cases of sore throat occurred in the 12 per cent of the households canvassed which were supplied with Deerfoot milk.

These figures furnish unquestionable evidence that the excess of tonsilitis in the month of May was directly related to the distribution of the Southboro milk supply. Whether we consider that

90 per cent of the sharp epidemic in Boston and Cambridge or 70 per cent of all tonsilitis in Brookline or 50 per cent of all sore throat in Brookline was associated with a route supplying in Boston 1 per cent, in Cambridge 2 per cent, and in Brookline 7 per cent of the total milk, it is quite clear that no coincidence can account for such facts. Of the 329 households in Brookline on the Southboro delivery lists, 85, or 26 per cent, had cases of tonsilitis, and, of the 626 households in Cambridge, 154, or 25 per cent, were infected.

These general statistical conclusions are borne out by a mass of individual observations which, taken singly, might mean nothing, but together and in connection with the general facts are highly significant. A number of the more striking of these cases may be briefly cited.

At the S. Club, an art students' boarding-house, there were 25 cases, and the milk supply was from the Deerfoot Farm. At the S. Bank down town, there was an outbreak which on May 13 doubled the normal absences; the lunch-room used Deerfoot milk. In an apartment house in Cambridge, three families had Deerfoot milk and three did not; there were four cases in the first three families and none in the last. In an Allston apartment house, two families had Deerfoot milk and four did not; every member of the first two families (eight persons), except a baby with a special milk supply, had tonsilitis. In another family in Cambridge three adults who had Deerfoot milk had tonsilitis, and the children, with another supply, did not. In a Boston family, four milk drinkers suffered and the other two members did not. In this and many other instances the severity of the disease was proportional to the amount of milk consumed. In a physician's family in Boston, the husband and wife drank no milk, while three children and three maids used Deerfoot milk and all these last had tonsilitis. A housekeeper in Cambridge worked in Boston at a house where the milk was taken, and she and four of the Boston family came down. A woman at the North End worked in the family of a Back Bay physician where the milk was used, and came down at her own house. A child at Chestnut Hill drank Deerfoot milk at lunch on the Back Bay on May 12 and later suffered, although there was no other tonsilitis in the neighborhood. A relative of a Cambridge family drank the milk at their home once, and came down with tonsilitis at a summer place on Cape Cod, 48 hours later. Miss T. had no Deerfoot milk in Cambridge, but lunched in town with friends who used it, and she and they came down. Miss G. in Cambridge was a chronic invalid living in a darkened room and seeing no one. Her diet was cereals and Deerfoot milk and she developed the disease. Three cases of the same peculiar type noticed in the Boston outbreak occurred in the city of Lowell; and it appeared that Deerfoot milk was supplied to the family by special arrangement. Half a dozen cases like those mentioned above, where the date of infection can be rather closely placed, all point to an incubation period of 48–72 hours.

It will be remembered that the dates of onset (Fig. I) of the epidemic indicated a minor preliminary outbreak about May 4.

Of the 18 cases which occurred on May 3–5, 13 were known to have been supplied with Deerfoot milk. I am inclined to believe, therefore, that there was a slight infection of the milk before that date, distinct from the heavy infection which caused the major outbreak.

Of the 48 fatal cases included in my records, 29, or 60 per cent, appear on the Deerfoot lists, and 12, or 25 per cent more, are believed by the physicians to have used the milk, leaving 7, or 15 per cent, apparently unconnected with the milk outbreak. In some of these latter cases, the primary attack may probably have been ordinary tonsilitis.

The theory of milk-borne infection is in entire harmony with the geographical and chronological distribution of the disease. It explains the heavy family incidence, and it is in harmony with the marked excess of disease among females, since women, as a class, probably drink more milk than men. The comparatively small proportion of children affected appears, at first sight, to bear against milk infection. It must be remembered, however, that this is a disease in which vital resistance plays a large part, and testimony is universal that this particular outbreak, when it attacked children, usually appeared in mild form. That there were not more recorded cases among the young is probably, therefore, due to their high resistance rather than to their freedom from exposure.

THE OUTBREAK IN HUDSON, MARLBORO, AND SOUTHBORO.

So far nothing has been said about the second focus of infection, in the towns of Hudson, Marlboro, and Southboro, 20 miles to the west of the Boston district. The more or less simultaneous occurrence of an outbreak of tonsilitis in this region, to a large extent unconnected with Deerfoot milk, was one of the chief objections to the theory that the Boston outbreak was milk-borne; and the objection at first appeared to be a serious one.

Inquiry among physicians in the three towns named soon showed that there had, indeed, been an outbreak of acute tonsilitis in all of them, and furthermore that the disease had been of exactly the same peculiar type observed in Boston. The physician's description of the disease, and its complications, tallied exactly with those given in Boston and Cambridge. The general diffuse redness of

many of the throats, the occasional diphtheria-like membranes, the high temperature and grippy pains, the large number of peritonsillar abscesses and cervical glands, the abscesses often showing little or no pus when opened, the recurrences, the resulting rheumatism, pneumonia, erysipelas, and nephritis were all noted. As in Boston, the disease was light with children and severe with older persons, but there were fewer very acute cases and no general septicemias. One death, probably attributable to the outbreak, occurred in Hudson, a man in middle life in whom the tonsilitis caused a sudden recrudescence of a chronic myocarditis.

Records were obtained altogether of 392 cases—97 in Hudson, 169 in Marlboro, 62 in the village of Southboro, and 64 in the two large Southboro boarding-schools. Excluding the school cases, the general epidemiological characters may be briefly considered and compared with the Boston data.

The household incidence is indicated in Table 8 and it is at once evident that the concentration of cases is much less than in the Boston outbreak. In the latter 56 per cent of the households had only one case and 22 per cent had three or more. In the Marlboro district over 83 per cent of the households had single cases only, and only 6 per cent had three or more.

TABLE 8.

FAMILY INCIDENCE, HUDSON-MARLBORO-SOUTHBORO OUTBREAK.

NUMBER OF HOUSEHOLDS IN EACH CLASS.

Town	Number of Cases in a Household			
	1	2	3	4
Hudson	59	8	6	1
Marlboro	124	13	5	1
Southboro	36	8	2	1
Total	219	29	13	3

The sex incidence, as shown in Table 9, was markedly different from that of the disease in the Boston region. In Boston, Brookline, and Cambridge the incidence was more than twice as heavy on females as on males; in Hudson, Marlboro, and Southboro males were affected most, 55 per cent of my cases being males and 45 per cent females.

Data in regard to age were obtained in Hudson, and are tabulated in Table 10. They correspond pretty closely with the Cam-

TABLE 9.

SEX INCIDENCE, HUDSON-MARLBORO-SOUTHBORO OUTBREAK.

	Male	Female	Unknown
Hudson	44	45	8
Marlboro	76	57	36
Southboro	27	18	17
Total	147	120	61

bridge data (Table 4), with the single exception that there were fewer cases among old people. I have no record of a single case over 65 years in Hudson, while 30 Cambridge cases were above that age.

TABLE 10.

AGE INCIDENCE, HUDSON OUTBREAK.

	Age Periods							
	0–5	6–15	16–25	26–35	36–45	46–55	56–65	Unknown
Cases	5	18	10	23	17	10	4	10

The real key to the Hudson-Marlboro-Southboro situation lies in the remaining factor, the distribution of the disease in time. The general facts are summarized in Table 11 for all three towns, but they can best be discussed separately, taking Hudson first as the simplest case.

TABLE 11.

DATES OF ONSET, HUDSON-MARLBORO-SOUTHBORO OUTBREAK.

DATE, WEEK BEGINNING	NUMBER OF CASES IN		
	Hudson	Marlboro	Southboro
March 27	..	4	1
April 3	..	26	5
10	..	14	2
17	2	10	..
24	18	14	3
May 1	24	15	5
8	14	36	15
15	16	37	11
22	12	10	20
29	1	3	..
June 5	4	..	..

In Hudson there is no Deerfoot milk delivered, and the fact that tonsilitis occurred there appeared at first sight to throw doubt on

the importance of milk as a causative factor in Boston. The distribution of cases shows at once, however, that we are dealing with a totally different condition from that obtaining in the Boston-Brookline-Cambridge epidemic. The Hudson figures are plotted in the upper half of Fig. III and the Boston, Brookline, and Cambridge figures for the corresponding weeks (but on a smaller vertical scale) in Fig. II. In Boston there was an explosive outbreak due

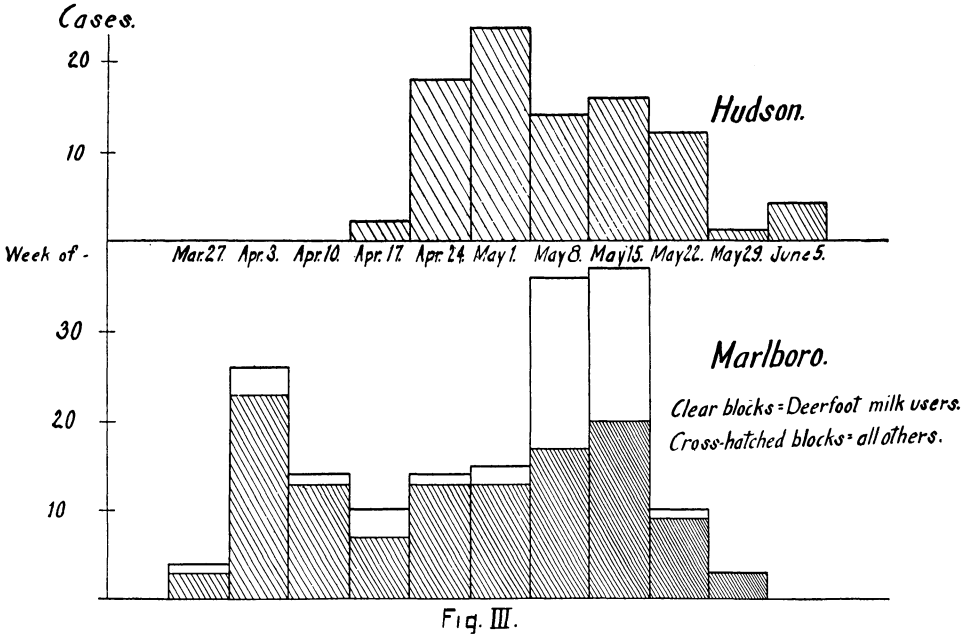

Fig. III.

Weekly Distribution of Tonsilitis Cases.
Hudson and Marlboro.

clearly to a single cause. In Hudson there was a gradual spread of the disease extending over a period of five weeks or more. The fact that other neighboring towns did not have the disease, while Hudson did, shows that there was specific infection and no effect of general climatic conditions; but a mere inspection of the dates of onset is sufficient to negative the idea of any common vehicle of infection localized in time. I was unable to find (by inquiry among the physicians) any common bond of location or association or food

supply between the cases. The infection must have spread in what is known as prosodemic fashion, as commonly occurs when influenza or diphtheria or ordinary colds spread through the community, not being carried by any single common vehicle like water or milk, but passing from one to another, by direct contact, by handling fruit or lead pencils or other objects that go into the mouth, and in a hundred different ways. Prosodemic disease always shows the slow, straggling development that appeared in the Hudson tonsilitis. It does not exhibit the marked concentration in families, characteristic of a milk outbreak, and it is more likely to affect young persons than the old, and men than women, on account of their more varied and widely ranging life.

Conditions in Marlboro were not quite so simple, but can be understood by a brief examination of the facts. Deerfoot milk, to the amount of about 800 quarts a day, was sold in Marlboro but the investigation made by Dr. W. W. Walcott, district inspector of the state board of health, showed that out of 40 affected families canvassed, only 18 had used this milk. A survey of the dates of onset of my 169 Marlboro cases (Table 11) shows that, as in Hudson, no single sudden infection could be expected, since the disease prevailed for at least eight weeks, practically through both months of April and May. The disease was confined to no one milk supply and no one section of the town, but spread gradually and by diverse routes through the whole community. Clearly this, as in Hudson, must have been for the most part a case of ordinary prosodemic infection.

On the other hand, it will be noted that the two weeks between May 8 and May 22 showed a particularly heavy incidence of tonsilitis, 36 and 37 cases, against 15 and 26 for the next highest weeks. These are precisely the weeks in which the milk epidemic occurred in Boston, Brookline, and Cambridge. The idea is naturally suggested by these facts that in Marlboro we are dealing with a twofold phenomenon, a prosodemic prevalence of the disease extending over the whole two months, and a milk epidemic coincident with that in Boston. I have compared the names of my cases with the Deerfoot delivery list, and the results plotted in the lower curve of Fig. III show that the conclusion is a correct one. Of the 96 cases in

Marlboro before and after the weeks of May 8 and May 15, only 12, or 12 per cent, were Deerfoot customers; of the 73 cases in the fortnight while the Boston outbreak was going on, 36, or 49 per cent, were Deerfoot customers. The cases among non-Deerfoot milk users (shown in cross-hatching) remained about as they had been; while the Deerfoot users (shown by the clear outlines) exhibited a marked increase. The tonsilitis which had been existing all through April and May in Marlboro was increased during these two weeks by the presence of milk infection, but the major part of the outbreak, like that in Hudson, was of other and, apparently, prosodemic origin.

In Southboro conditions were essentially the same. Tonsilitis of the peculiar type in question existed all through the months of April and May, but was increased after May 8 by milk-borne cases. Notably, the two boarding-schools in the town suffered from a clear-cut Deerfoot milk epidemic of 42 cases among the 169 boys at St. Marks and 17 cases among the 70 boys at the Fay School. These figures are not included in the previous tabulations, which include only the 62 cases reported from the village of Southboro. In the adjoining town of Westboro there were a few cases of the prosodemic type, five, of which I have records, occurring in the month of April.

Two questions suggest themselves in connection with a comparison of the two outbreaks which I cannot answer altogether satisfactorily. The first is why there was not a more severe epidemic of milk-borne tonsilitis in Marlboro between May 8 and May 22. If the milk had been as heavily infected as in Cambridge there should have been several hundred cases, yet I found records of only 36 cases among Deerfoot users during this fortnight, after interviewing almost all the local physicians. The Marlboro milk is bottled last, after the Boston car is filled, and perhaps the infection may have occurred earlier in the run. Again, the Marlboro milk is held for the 20 hours or so between bottling and delivery in a cold-storage room, while the Boston milk is in a freight car, though of course packed in ice. It may be that the Boston milk was not quite so thoroughly cooled and underwent a greater multiplication of the infectious germs. The other point of interest lies in the fact

that while the tonsilitis germ had apparently been spreading in prosodemic fashion in Marlboro and Southboro and Hudson, after it reached Boston in the milk it did not continue to spread in this way, as evidenced by the almost complete absence of secondary cases. The sanitary conditions in the households affected in Boston were not such as to favor prosodemic spread of disease; but this seems hardly competent entirely to account for the phenomena. It is possible that the character of the germ may have been modified by its sojourn in the milk, and modified in the direction of a closer adaptation to a rich food medium. If so, the same changes that made it more virulent for the human beings who ingested it might have made it less able to endure dryness and other unfavorable conditions outside the body, and therefore less likely to be spread in prosodemic fashion. Or, again, the prosodemic spread of tonsilitis may require the action of contributory environmental causes, such as cold or dryness or dust, which ordinarily occur in spring, and such causes may have been lacking in Boston by the end of May. We know that throat diseases do prevail in spring and decrease in summer; and it is significant that the prosodemic tonsilitis which had been prevalent in Hudson, Marlboro, and Southboro for two months ceased at the same time.

CONNECTION BETWEEN THE HUDSON-MARLBORO OUTBREAK AND THE EPIDEMIC IN BOSTON, BROOKLINE, AND CAMBRIDGE.

The general facts, as they have so far been reviewed, appear to indicate that a rather definite form of acute tonsilitis was prevalent in prosodemic form in Hudson, Marlboro, and Southboro all through the months of April and May, while in the second week of May it suddenly appeared as an acute epidemic connected with the distribution of Deerfoot milk in Boston, Brookline, and Cambridge on the one hand, and to a less extent in Marlboro and Southboro on the other.

There are two sources to be considered for an infection of the type under consideration: cattle and human beings. In most of the similar outbreaks of throat disease which have occurred in England it has been found that the cows were suffering from inflammation of the udder and it has been held that the same germ which caused

these conditions produced the throat infection in the human subject. It was natural, therefore, to think first of the possibility of such an origin in the present case. Two reasons, however, appear to militate against such a conclusion. In the first place, Dr. J. W. Robinson, the veterinarian of the Deerfoot Farms Company, made a thorough examination of all the cattle tributary to the Southboro dairy as soon as possible after May 15, without finding a single case of udder disease. In the second place, circumstantial evidence points to an easy possibility of infection from human sources.

The milk of the Southboro dairy, to which statistical evidence points as the carrier of the infection to Boston, is derived from farms lying mostly in the town of Southboro, but some in adjacent sections of Westboro, Framingham, and Marlboro. It is significant that this district was precisely the one place in Massachusetts where tonsilitis is known to have existed in epidemic form during the month of April, 1911. I have records in my canvass of six cases in the Boston region during this month, of five in Westboro, 11 in Southboro, 20 in Hudson, and 68 in Marlboro (Fig. IV). I do not mean of course to imply that no tonsilitis cases occurred in other cities and towns or that only six cases occurred in Boston and Brookline. I do believe, however, that I have canvassed the situation in the adjoining towns—Framingham, Wellesley, Natick, etc.—sufficiently to make sure that there was no unusual excess of tonsilitis there in either April or May. The four cases in Boston and the two in Brookline represent ordinary non-epidemic tonsilitis which happened to be reported by the doctors interviewed, and it is significant that not one of the six is known to have used Deerfoot milk.

The fact that the particular disease in question prevailed among human beings to a notable and unusual degree in precisely the region where the Southboro milk is collected would alone furnish a reasonable presumption that this, rather than a suppositious cattle disease, was the source of infection; and a careful study of conditions in Southboro tends to strengthen this hypothesis.

The examinations made on May 15 by Professor Prescott and Dr. Robinson failed to show a single case of throat disease on any

of the Deerfoot farms. At the Deerfoot dairy building they found, by questioning the men, that half a dozen were suffering from more or less severe throats, but these cases were plainly partakers in the main outbreak and not causal in relation to it. I have found record of other earlier cases, however, three of which are perhaps significant as indicating the presence of infection in the immediate vicinity. One of the first cases on March 31 was the daughter of Mr. B., an engineer at the dairy. He himself came down on April 6, and had a relapse on May 6. Mrs. R., the wife of the man who receives all the milk at the dairy and pours it into the

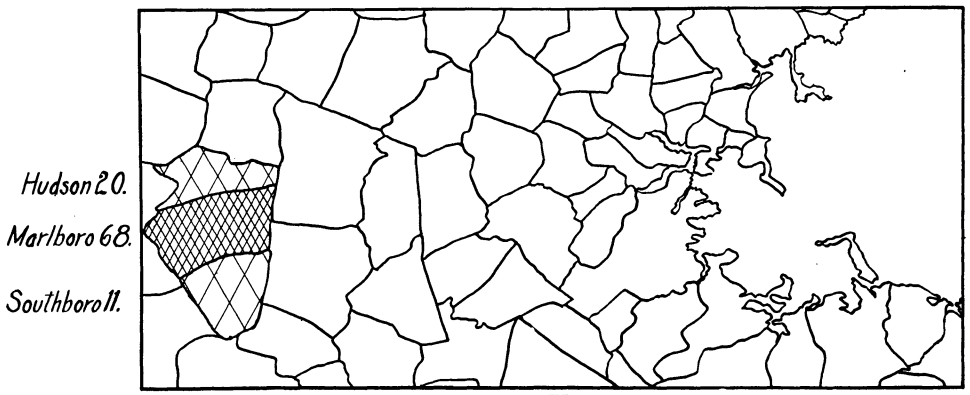

Fig. IV.
Tonsilitis in Eastern Massachusetts. April.

mixing tanks, had tonsilitis during the first week of May; and at the same time the two children of Mr. H., a farm hand at the Deerfoot Farm itself, were suffering from tonsilitis. None of the persons known to be sick is supposed to have come into contact with the milk, and neither did Mr. H. himself. So far as I am aware, no one who actually handled the milk or the bottles or cans had tonsilitis until May 13, when Mr. X., who washed the cans, fell ill, and his case was more probably a result of the epidemic and not a cause. It is well recognized, however, that, when an infection is spread generally through a community as this throat disease was, among the workers and their families at the dairy and at the farm, there are always "carriers," incipient and walking cases, who, without symptoms of actual disease, are carrying about and dis-

charging virulent germs. Such a carrier case presumably infected the milk, although under the circumstances it is of course impossible to identify the actual link in the chain of infection. It is precisely such dangers as this which have so often rendered vain the most earnest efforts to protect a milk supply; and the chance of overlooking light cases was of course particularly great with a disease like this tonsilitis, which was often mild in character and which had never been known in this country to have been milk-borne.

Wherever and however the infection may have entered, it seems tolerably certain that the germ must have multiplied in the milk

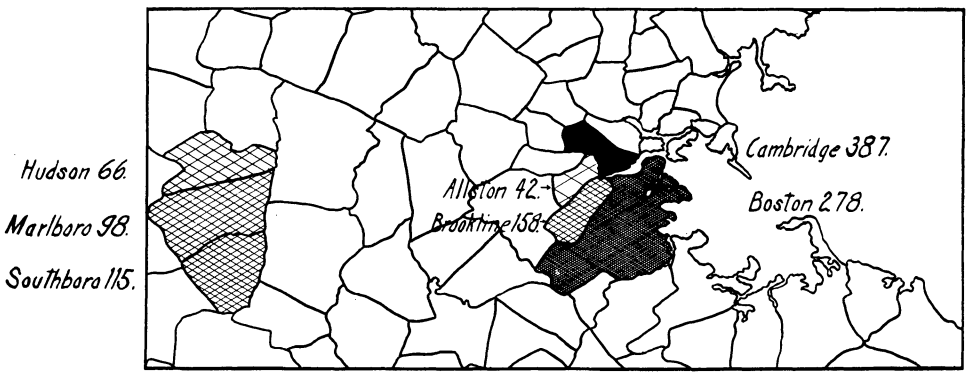

Fig. V.

Tonsilitis in Eastern Massachusetts. May.

in order to produce such an extensive and acute infection as that which followed. In Brookline and Cambridge, where my records are most complete, one house in every four supplied with Deerfoot milk is known to have been infected; in 44 per cent of the families there was more than one case, and in 22 per cent, more than two cases.

PRECAUTIONS TAKEN AT THE DEERFOOT DAIRY TO GUARD AGAINST INFECTION.

The milk which caused the epidemic was all morning milk, brought by team to the Southboro dairy a few hours after milking. The cattle at the farms are inspected at least four times a year by Dr. J. W. Robinson, the veterinarian, and the sanitary conditions are regularly inspected by him and are checked by bacterial

analyses, made six to eight times a month, by Professor S. C. Prescott. The stable rules communicated to all farmers call for carding and brushing of cattle at least once daily, and bedding with a clean, dry, absorbent bedding. Stables must be well lighted, well ventilated, and kept clean, and whitewashed at least twice a year. The udders and flanks of the cows are to be thoroughly cleaned before milking, preferably by washing or wiping with a damp cloth. Milking is to be done with dry hands and by milkers in clean clothes, and the milk must be at once removed to a suitable milkroom. Rules in themselves, of course, mean little, but the bacterial results obtained, some of which will be cited later, indicate that these rules have been enforced with considerable success.

The use of milk from any cow that has trouble of any description with her udder is forbidden; and most important of all in connection with the present epidemic, stringent rules are in force against the danger of human disease. Milk from any farm where sickness occurs is not used, but is paid for in full, and every effort has been made to acquaint the farmers with this system. Every year a circular of instructions is sent out containing passages like the following:

> In the question of sickness, for instance in cases of typhoid fever, scarlet fever, small pox, or diphtheria, if the farmer announces at the dairy immediately this condition he will be paid the regular price for all his milk, though it is not used. If the information of said sickness should come from outside parties or through the local boards of health first, we shall consider it fair and proper to drop for the time being the milk from any farm where the above conditions exist and shall make no payment for the milk from the time of stoppage until delivery can be resumed.

August 24, 1910, the following letter was sent out to all farmers:

> Owing to the prevalence of typhoid fever in the neighboring towns it is necessary that we should take extra precautions to safeguard our milk supply, as milk is a very favorable medium for the growth of this disease. For this reason we think it best to remind you at this time of our promise to pay for all milk withheld in case of sickness from this or any other contagious disease if our patron notifies us himself, and at once, of any such sickness in his household or among his employees. If, however, the information comes from outside sources rather than from our patron, we shall consider if fair and proper to drop his milk for the time being without pay for the same. If there should be symptoms of contagious disease and you are in doubt, if you will call a physician for an examination and send us the bill we will pay the same.
>
> An epidemic of typhoid or other contagious disease traced to our milk would cause a great deal of trouble for all concerned and seriously affect the demand for milk.

Information should not be withheld on account of a light case, as it is quite as likely as a severe case to transmit the disease.

We do not wish our patrons to suffer any financial loss and will see that they do not if they will but follow our suggestions. In case of contagious disease it will merely mean withholding your milk for the time being, sending us a report of the same at the end of the month, and you will receive your cheque the same as if the milk were used. We wish to ask your co-operation with us in this regard as it is the only way that we can maintain our record of never having had an epidemic of any contagious disease traced to our supply.

It is difficult to see what more could have been done along these lines; yet even such precautions failed to prevent the infection of the milk with which we are concerned. It should be noted, of course, that the particular infection was only a sore throat and thus much more liable to escape detection than one of the recognized epidemic diseases; and even so the probability is that the infecting agent was an unrecognized carrier rather than a well defined case.

When the milk arrives at the Deerfoot Dairy it is at once smelled (not tasted) for acidity and then poured into a pipe leading to the mixing tank. This pipe passes through a partition, and the mixing tank itself is in a clean white-painted room which no one enters during the working period. Only the one man who smells the milk and pours it into the pipe comes into contact with it after it reaches the dairy. From the mixing tank the milk passes in closed pipes to a centrifugal clarifier; and thence to a bottling machine, bottling and filling being conducted automatically and without human intervention.

The mixed milk from the Southboro dairy and the separate milk from all the individual dairies are examined by Professor S. C. Prescott, as noted above, and he has kindly furnished me with all his records for the month of May. The results for the mixed Southboro milk are shown in Table 12; the quantitative figures represent counts made after 24 hours at 37°. The samples of milk were also examined after centrifuging for leukocytes and streptococci with no excess of either in any sample.

The counts obtained on the separate samples from the individual farms are of course still lower. Of 1,204 farm samples examined in May (including both Northboro and Southboro supplies) only seven showed over 500,000 bacteria per c.c., 22 between 250,000

and 500,000, and 49 between 100,000 and 250,000, while 604 samples had less than 10,000 and 882 samples had less than 50,000.

I am at a loss to suggest any other precautions that could have been taken to guard against infection with human germs of disease, that were not taken in this instance. Excellent regulations were drawn up for the exclusion of contagion, the farms and cattle were carefully inspected, the dairy was admirably arranged, and the whole process controlled by laboratory examinations under the direction of a bacteriologist and sanitarian of the highest standing. If, in

TABLE 12.

BACTERIA PER C.C. IN SOUTHBORO BOTTLED MILK.

Date	Number in Each of Several Samples		
May 1	200,000	120,000	140,000
3	23,000	75,000	250,000
5	30,000	15,000	10,000
8	35,000	.....	.....
10	170,000	200,000	80,000
15	45,000	70,000	75,000
18	100,000	150,000	60,000
24	150,000	150,000	130,000
26	45,000	300,000	200,000
29	85,000	95,000	45,000

spite of such precautions, the Deerfoot milk became infected, any raw milk supply may at any time become infected; and this I believe to be the lesson, not only of this outbreak, but of many that have preceded it in all parts of the world. It is practically impossible to exclude mild and unrecognized cases of disease from contact with the process of milk production. The larger a supply, the greater of course is the danger; but even a small supply must meet it at some time. Then a cough over the pail, a finger inside the can as it is lifted, and the danger is imminent.

Boston has suffered severe lessons along this line. In 1907 there were 717 cases of scarlet fever traced to one milk supply and 72 cases of diphtheria to another.[1] In 1908 there was a milk-borne outbreak of typhoid fever totaling 400 cases.[2] In 1910 there was another scarlet fever epidemic of 842 cases.[3] Including the present outbreak there have been over 3,000 cases of epidemic disease traced to milk in the immediate neighborhood of Boston in a period of five years.

There is, in my judgment, but one certain safeguard against such outbreaks—proper pasteurization; but two things must be

[1] *Rep. State Bd. Health, Massachusetts*, 1907, 39, p. 489.

[2] *Ibid.*, 1908, 40, p. 751.

[3] *Monthly Bull. State Bd. Health, Massachusetts*, July, 1910, p. 298.

understood in recommending pasteurization as a general practice. Pasteurization has been too often used in the past by unscrupulous dealers to cover up milk so dirty as to be unsalable without it. Regulations as to sanitary inspection and bacterial counts are just as imperative for milk to be pasteurized as if it were to be sold raw, and the standards should be set just as high as economic conditions permit. In the second place, many processes of pasteurization do not pasteurize. No process should be accepted unless the milk is held at a temperature of at least 145° F. for 20 minutes. The systems of "flash" pasteurization are often worse than useless. Finally, the milk must be properly protected from secondary contamination after pasteurization. The treated milk should either be conducted in closed pipes to an automatic bottling machine; or, best of all, the pasteurization should be conducted in the final package ready for delivery.

The process introduced at the Deerfoot Dairy since the outbreak for the preparation of pasteurized milk for those who desire it, which consists in bottling as usual, capping with a metal cap, submerging in a tank of water and heating for 30 minutes at 150°, seems to me worthy of special commendation, since it excludes all personal contact of attendants, possibly suffering from infectious disease.

SIMILAR OUTBREAKS OF MILK-BORNE SORE THROAT IN OTHER COUNTRIES.

So far as I am aware, no milk epidemic of tonsilitis or similar throat disease has been hitherto reported in this country. In Great Britain, however, the phenomenon has been a common one. Swithinbank and Newman[1] even go so far as to say "it is safe to assume that a year never goes by in which there are not outbreaks of sore throat or tonsilitis due to milk or cream."

Two more or less distinct types of epidemics may be distinguished, those in which the throat disease resembles atypical scarlet fever and is perhaps associated with definite scarlet fever cases, and those, like the one we have been considering, in which tonsillar and peritonsillar infection followed by septic invasion are the chief symptoms. Of the first type was the epidemic at South Kensington in 1875,[2] where 20 persons who had used cream from a district where 119 cases of sore throat had occurred suffered, some from sore throat and some from scarlet fever. At Oxford in the spring of 1882[3] there was a case of scarlet fever in a dairy farm between February 27 and March 3.

[1] H. Swithinbank and G. Newman, *Bacteriology of Milk*, London, 1903.

[2] *Rep. of Med. Off. to Local. Gov't Bd., Great Britain*, 1875, 7, p. 80.

[3] *St. Bartholomew's Hosp. Rep.*, 1884, 20, p. 93.

Between March 7 and 15 there developed among 85 persons using this milk 14 cases of sore throat, six of scarlet fever, and one of diphtheria. At Upton and Macclesfield in 1889[1] between January 24 and February 4, 83 cases of sore throat, 38 of scarlet fever, and two of diphtheria broke out among the customers of a single milk supply. Newsholme[2] reports a small outbreak of nine cases of sore throat and seven of scarlet fever at Brighton, which he believed to be due to milk, on grounds which do not appear altogether conclusive. The interesting thing about these epidemics is the possibility they suggest of a common causative agent for scarlet fever and a comparatively mild throat infection; but they have of course no direct bearing on the epidemic under immediate consideration.

Outbreaks of the second class, definitely of the tonsilitis or quinsy type, are much more common and often present a striking parallelism with the phenomena of the Boston epidemic.

At Aberdeen in 1881,[3] 90 families were affected, out of a total of 110 supplied by a single dairy, and in the 90 families there were 300 cases. The onset of the disease was marked by severe rigors followed by fever, and both throat and tonsils were inflamed, but without the formation of a false membrane. After two to four days the fever subsided, leaving great prostration. Relapses were common and the lymphatic glands frequently became swollen and remained enlarged for a long time. Three deaths occurred among old persons.

A similar outbreak was studied by Dr. George Wilson at Rugby School in 1881.[4] Between March 16 and 18 sore throat broke out in three of eight boarding-houses, about 30 cases to a house. It was found that these three houses alone had a common milk supply and that of 37 houses in the town supplied by the same dealer, 15 were affected. In neither the Aberdeen nor the Rugby outbreak was the source of infection discovered, though the presence of milk from a gargety cow was suspected in the latter case.

In 1884 there was an outbreak in Dover which resembles our own in many respects.[5] One hundred eighty-eight persons were attacked during a period of four days, and the epidemic occurred in the best districts of the town, and was notably severe among domestic servants. Family incidence was heavy, 31 households having a single case each; 21, two cases; 15, three; seven, four; five, five; three, six; one seven; and one, nine cases. The primary inflammation of the tonsils was often accompanied by a vesicular eruption of the throat and followed by enlargement of the lymphatic glands of the neck. Recovery was much slower than in ordinary quinsy, the cervical glands remaining tender and swollen. Rheumatism, erysipelas, and general septic conditions ensued as complications. Evidence connecting the outbreak with a particular milk supply was clear. In 19 streets every house supplied by the particular milkman was attacked, and in 23 other streets 51 out of 86 houses suffered. The infection of the milk was attributed to the fact that the cows in the dairy in question had suffered from foot-and-mouth disease in January.

G. Sims Woodhead and J. M. Cotterill investigated an outbreak at an educational institution in Edinburgh in 1888,[6] in which the cows suffered from an epidemic of cowpox which was supposed to be the source of the human infection. The connection

[1] *Rep. of Med. Off. to Local Gov't Bd., Great Britain*, 1889, 19, p. 89.
[2] *Jour. Hyg.*, 1902, 2, p. 150.
[3] *Brit. Med. Jour.*, 1881, 1, p. 657.
[4] *Ibid.*, 1881, 2, p. 415.
[5] *Practitioner*, 1884, 32, p. 467.
[6] *Brit. Med. Jour.*, 1888, 1, p. 1235.

between cattle disease and human disease appears in most of these instances to be somewhat tenuous, but the circumstantial evidence as to the responsibility of the milk is clear enough, whatever the original source of milk infection may have been. In the Edinburgh outbreak 60 cases of sore throat developed between October 10 and October 20. The milk from the suspected source was stopped and the epidemic ceased. The use of the milk was resumed on November 7, and in the next five days 25 more cases occurred, and the outbreak was again checked by boiling the milk.

Similar phenomena marked the epidemic at Rothesay in 1890.[1] Eighty cases developed between March 16 and April 2. Intense inflammatory hyperemia of the throat was observed, with patches of exudate in some cases and much enlargement of the glands. Temperature varied from 102° to 105° and great prostration was experienced. Rheumatism and many severe attacks of erysipelas followed as complications and three children died. It was found that two milkmaids at the suspected dairy had had sore throats between March 11 and March 17. On April 2 the use of the milk was stopped, and the epidemic ceased. It was used again on May 6 and by May 10 fresh cases began to develop.

In 1900 J. K. Warry reported an outbreak of septic sore throat in the borough of Hackney.[2] One hundred fifty-one cases of a septic sore throat, closely resembling that observed in the Boston outbreak, were found in 88 households. In every case there was tonsilitis, but not of the ordinary follicular type; and swelling of the cervical lymphatic glands, more or less unilateral. Temperature was high, prostration great, and convalescence protracted. In one case acute septicemia supervened, followed by a fatal pneumonia, and in two cases acute nephritis set in. The only differences between this outbreak and that of May, 1911, in Boston are that the temperature in the Hackney cases assumed a remittent type with night sweats and that a large proportion of children was affected. One hundred thirty-eight of the 151 cases of sore throat, or 85 per cent, were supplied by a single milk dealer, and a canvass of two selected areas showed 29 per cent and 14 per cent of his houses affected, against 2 per cent and 0 per cent of the houses supplied by other dairymen.

An outbreak at Lincoln in 1902[3] showed symptoms somewhat intermediate between typical septic sore throat and the epidemics of atypical scarlet fever. Seventy-five cases developed in a single week in the month of May, all but one having a common milk supply. Besides the sore throat and swelling of the cervical glands there was noted erythema of the face, edema of the fauces and uvula, and a coating of drab-colored fur on the tonsils. About two-thirds of the cases exhibited a roseolous papular eruption, and desquamation occurred in a third of the cases. Joint infections and peritonitis followed as complications.

An epidemic of 42 cases of septic sore throat in 22 families at Bedford[4] showed symptoms more like those of influenza, severe pains and some gastric disturbance, with a temperature of 102° to 103°, accompanying the inflammation of throat, fauces, palate, and uvula. Every case used milk or cream from the same dairy. Twice as many females as males were affected, and 22 of the 42 cases were under 20 years of age.

It may be noted that in none of the last three outbreaks, at Hackney, Lincoln, and Bedford, was any original source of infection either human or bovine demonstrated at the farm or dairy from which the infected milk was derived.

[1] *Glasgow Med. Jour.*, 1890, 34, p. 241.

[2] *Ann. Rep. Med. Off. of Health*, Hackney, 1900.

[3] *Lancet*, 1902, 2, p. 1391.

[4] *Ann. Rep. Med. Off.*, Bedfordshire County Council, 1902.

An outbreak of septic sore throat at Woking in 1903[1] was of the same general type as the Boston epidemic. Two hundred fifty cases and eight deaths occurred in the months of October and November. Many of the throats were of the ordinary follicular type, others showed a definite membrane suggesting diphtheria, others still would have been classed as quinsy. The temperature was high and accompanied by grippy pains and the cervical glands were frequently involved and were slow to heal. Rheumatic affections of the joints, erysipelas, and peritonitis occurred as complications. Adults were chiefly affected and the course of the disease was more severe in them. It was found that the cases were concentrated on the routes of two dealers, both of whom derived a portion of their milk from a single farm. On this farm four cows were found yielding from certain teats immense quantities of pus and streptococci. The farmer had suffered from quinsy in the middle of September, followed by joint pains, and his wife and four children had been attacked in October.

In an epidemic of sore throat among the staff of the Belvidere Hospital, at Glasgow, there was evidence of bovine infection.[2] A new cow was added to the herd on April 23. The cows associated with the newcomer quickly developed a teat eruption until by May 6, 30 per cent of the herd had been attacked. Thirty-nine cases of sore throat appeared among the users of the milk during the month of May and the hands of four milkers were found to be affected with sores.

In the same year an outbreak of 100 cases was reported by Robb[3] at Paisley but with little detail. There was acute inflammation of the throat with enlarged tonsils and a diphtheria-like membrane, pains, severe toxemia, and great prostration. The "only common factor known was milk supplies" and the cattle had recently suffered from cowpox.

An epidemic at Colchester in 1905[4] again resembled the Boston outbreak. One hundred forty cases occurred during the month of April in one of the best residential sections of the town. Many servants were attacked, and, among those whose sex was recorded, were 43 adult females, against 13 adult males and 18 children. The incubation period was about two days. Onset of the disease was rapid, with high temperature, often 104° or 105°, and pains in the limbs. The throat was red and swollen, with follicular plugs which sometimes ran together to form a diphtheria-like membrane. The submaxillary glands were enlarged and painful, sometimes leading to a condition of quinsy. There were few secondary cases. In the neighborhood affected, 97 per cent of the cases had used the suspected milk and a house-to-house canvass showed that, of households supplied with this milk alone, 51 per cent were attacked, of those supplied with this and other milk, 33 per cent were attacked, and of those supplied only with other milk, 6 per cent were attacked. There occurred also, simultaneously, 60 cases in the army barracks supplied with the same milk. On one of the tributary farms a cow was found with a diseased udder yielding pus, and on this farm six cases of the disease occurred during the course of the epidemic.

No attempt has been made to search the literature systematically and references to the papers describing most of the outbreaks cited were originally obtained from Swithinbank and Newman's *Bacteriology of Milk* or from *Bulletin 56* of the U.S. Public Health and Marine Hospital Service. Excluding the outbreaks complicated by scarlet fever, 12 epidemics of sore throat disease have been briefly reviewed. In certain cases the symptoms were somewhat different from those observed in the Boston-

[1] *Jour. State Med.*, 1904, 12, p. 595.
[2] *Pub. Health*, 1904, 16, p. 769.
[3] *Ibid.*, 1904, 17, p. 773.
[4] *Ibid.*, 1905, 18, p. 1.

Brookline-Cambridge outbreak. In other cases, as at Aberdeen, Dover, Rothesay, Hackney, Woking, and Colchester, both primary symptoms and secondary complications were so similar as to make it appear highly probable that we are dealing with the same quite definite disease. In four of the 12 outbreaks there was no evidence whatever as to the original source of infection, and in four other cases there was a dubious connection, only, with some bovine disease. At Glasgow and Colchester there was fairly strong circumstantial evidence of a connection with inflammation of the cow's udder. At Rothesay probability pointed to human infection, and at Woking there had been both human quinsy and bovine udder inflammation on the farm.

SUMMARY AND CONCLUSIONS.

A sudden outbreak of a peculiar form of acute tonsilitis, or septic sore throat, occurred in Boston and its vicinity during the month of May, 1911. Suspicion was directed toward a certain milk supply, that of the Deerfoot Farms, but there were puzzling circumstances which led to a difference of opinion and to a suspension of judgment in official circles. At the request of the officers of the dairy company, I made an investigation of the statistical and epidemiological side of the problem during the summer months.

The disease was not ordinary follicular tonsilitis, but more nearly what the English recognize as septic sore throat. In early stages there was merely a diffuse redness over the tonsils and adjoining regions, but follicular patches often appeared later and in many cases a membrane simulating that of diphtheria. Peritonsillar abscesses and enlarged cervical glands, of a stubborn nature, marked the second stage of the disease, and these were followed by diverse complications—rheumatism, erysipelas, nephritis, pericarditis, pneumonia, pleurisy, peritonitis, and general septic conditions. The disease was severe, and occasionally fatal among the old and weak. Inquiries made by the district inspectors of the state board of health and supplemented by my own investigations made it clear that the disease in question, so far as any abnormal epidemic prevalence was concerned, was confined to two definite foci centering respectively about Boston on the seacoast and about Marlboro, 25 miles to the westward.

The Boston epidemic affected the Back Bay and other regions of Boston, the town of Brookline, and the city of Cambridge. Through the courtesy of the Boston and Brookline boards of health and by personal interviews with physicians (over 80), I have

obtained records of 1,043 cases in this vicinity. They form a sharply marked epidemic, beginning on May 8, rising to a maximum on May 14, and practically ceasing after May 22. There were few secondary cases and a single common source of infection for the three communities is clearly indicated. Cases were concentrated in the families affected, only 56 per cent of the households having a single case and 22 per cent having three cases or more. Females suffered twice as much as males. Adults suffered more in proportion than children. Only 15 per cent of the cases were under 16, 44 per cent between 16 and 35, 23 per cent between 36 and 55, and 17 per cent over 55. Forty-eight deaths were attributed to the epidemic, but in some cases the fatal complications were somewhat remote. Two-thirds of the fatalities occurred at ages above 55, and one-third at ages above 75.

It soon appeared that the distribution of the epidemic exactly coincided with that of one of two main milk supplies of the Deerfoot Company. It affected the particular districts in Boston, Brookline, and Cambridge where this milk was used, and it broke out simultaneously in Marlboro and Southboro, the only other towns to which it was distributed. The cases obtained from physicians in Boston and Cambridge were compared with the delivery lists of the dairy, and over 85 per cent were found there, while an additional 8 per cent were stated by physicians to have used the milk, though not listed as subscribers. The Deerfoot supply makes up about 1 per cent of the Boston and 2 per cent of the Cambridge total. In Brookline my records include all cases of tonsilitis reported in answer to a circular sent out to all physicians and covering a period of five weeks. These data, including not merely the epidemic, but ordinary tonsilitis as well, showed 65 per cent of the cases on the Deerfoot lists and 8 per cent more stated to have used the milk. The Deerfoot supply was about 7 per cent of the total for the town. A study of the delivery lists for Brookline and Cambridge, where my records were fairly complete, showed that in each case about one family out of every four supplied had been infected.

The other outbreak, in the region of Marlboro, seemed at first to complicate the situation. The disease which prevailed there was exactly the same type which occurred in Boston and I obtained

records of 392 cases in the three towns of Hudson, Marlboro, and Southboro. The household incidence was much less marked than in Boston, and instead of a large excess among females there was a slight excess among males. A study of the dates of onset indicated that the epidemiological conditions were entirely different from those in Boston. Instead of a sudden explosive outbreak the disease was present all through the months of April and May, and was evidently spreading from person to person in ordinary prosodemic fashion without any single common bond. In Hudson, where Deerfoot milk is not sold, there was a fairly even distribution over a period of five weeks. In Marlboro and Southboro, on the other hand, in addition to the general prevalence of the whole period, there was a special outbreak simultaneous with that in Boston, during the second and third weeks of May. While the cases occurring during the other six weeks in Marlboro were chiefly among the users of other milk supplies than Deerfoot, the excess in the epidemic period was wholly among Deerfoot customers. In Southboro there was at this time an epidemic of 64 cases in two boys' boarding-schools supplied with Deerfoot milk.

It appears, then, that the peculiar type of tonsilitis in question prevailed in prosodemic form in Hudson, Marlboro, and Southboro during April and May, and in the second week in May appeared as a sharp epidemic, following the Deerfoot milk, in Boston, Brookline, and Cambridge, and in Marlboro and Southboro. The Deerfoot milk associated with the epidemic is derived from farms in Southboro, Marlboro, and the adjacent regions, and probability points to an infection of the milk from the human cases known to be so abundant in this neighborhood. No record has been obtained of any well defined case of tonsilitis in direct contact with the milk. Cases are known to have occurred, however, at the proper time in a family on the Deerfoot Farm and in the families of employees at the Deerfoot Dairy. It is probable, therefore, that the actual infection was due to a carrier case. No cattle disease is known to have occurred on any of the farms.

I am unable to find that any of the natural precautions which could be taken to prevent infection of the Deerfoot milk had been neglected. Farms and cattle were systematically inspected by an

expert veterinarian. It was well understood that milk from a farm where contagious disease existed should be paid for and not used. Facilities for handling the milk at the dairy were of the best, and the whole process was controlled through frequent bacteriological analyses by a sanitary expert of the highest standing. The lesson to be drawn from the outbreak is that even a most carefully supervised milk supply is open to the danger of grave infection from carrier or unrecognized cases of disease. The only real safeguard against such catastrophes lies in pasteurization, carried out by the holding system and preferably in the final packages.

Numerous outbreaks of similar throat disease have occurred in Great Britain, and have been clearly traced to infected milk supplies. From the English experience it appears that "septic sore throat" is by no means rare as a milk-borne infection; and sanitarians in this country must add this to the list of dangers that surround a raw milk supply.